GROWTH, INSTABILITY AND LAND DEGRADATION IN ANDHRA PRADESH AGRICULTURE

32600

Sanatan Nayak

GIRI INSTITUTE OF DEVELOPMENT STUDIES
Sector O, Aliganj Housing Scheme
LUCKNOW 226 024

2003

Growth, Instability and Land Degradation in Andhra Pradesh Agriculture

Sanatan Nayak

This paper highlights the agricultural performance, nexus between instability with growth and finally the extent and impact of land degradation on crop output in Andhra Pradesh during the last three decades of the post green revolution period. The study found that the growth rate of foodgrains production in nineties is quite less than that of seventies, whereas the growth rate of non-foodgrains in nineties is less than that of eighties. Most significantly, rice being the staple foodgrains and is grown in the large tracks of irrigated areas of the state but its growth rate has been declining in nineties compared to that of seventies and eighties. In addition, high instability coupled with land degradation caused for decline of crops output in recent years. The blueprint includes improved irrigation, appropriate use of fertilizer, and reduction of subsidies in fertilizer and use of manures.

I   Relevance of the Study

Maintaining efficiency, stability and sustainability in agricultural sector is the country's greatest need. In order to achieve stability, sustained growth of agricultural production is essential. However, maintaining stability is not enough in order to fulfill the increased need of foodgrains in a growing populated country like India. Hence, for achieving efficiency in agricultural sector is to step up agricultural growth over and above the rate already achieved in the past is essential. In addition, the accelerated growth of agricultural production should be stable with the increase in the application of high yielding technology, which would reduce the rural urban disparity and also help in achieving a higher reduction in rural poverty (Rao, 1994). The sustainability aspect plays crucial role for the economic development of a nation. Extensive use of natural resources like land, water, forest etc., degrades the quality of these resources. Eventually, this threatens a large extent for the prosperity of the posterities (Rao, 1994; Reddy, 1995). Hence, proper policy measures are to be implemented in different dimensions to maintain the above-mentioned aspects. In this connection, the problems associated with states, as well as regional level are no way different from the national level. The agricultural performance of Andhra Pradesh has shown the same characteristics during post green revolution period. Hence, the study of agricultural performance of the above-mentioned aspects creates tremendous importance at various regions of Andhra Pradesh during post green revolution period.

Andhra Pradesh is the fifth largest state both in terms of area and population in the country. In the state, 68.3 per cent of the total working forces depend on agricultural sector and contribute 39.5 per cent of the state domestic products (Government of India, 2000). The state occupies dominant position in all India level, i.e., 4th and 5th position, so far as total irrigated area and total foodgrains production are concerned. Andhra Pradesh has the prime position of being one of the major contributors to the agricultural performance in India. This has been happening because the state along with speed infrastructural development could reap the maximum benefits of green revolution. The view of production figures shows that the introduction of HYV seeds and associated technology, the total foodgrains production increased by 1.84 times, the yield of rice increased by 1.73 times, total production of cereals increased by 2.03 times during 1970-99. The yield potential of modern varieties was fully exploited with the increase of fertilizer use and increase of investment in irrigation.

In view of the above, the study would like to focus on the following aspects of the Andhra Pradesh agriculture. Firstly, the performance of agriculture in terms of changes in cropping pattern, growth performance of both foodgrains and non-foodgrains, regional differences in the production of foodgrains. Secondly, it focuses on the instability of growth pattern of all crops, extent of instability, nexus between growth and instability and the factors behind it. Thirdly, the study tries to find out the extent and causes of environmental degradation and its impact on crop output. Hence, thorough evaluation is essential for the above aspects by taking latest crop data in various regions of Andhra Pradesh in order to provide right policy measures to enhance agricultural growth in years to come.

The growth performance is evaluated on the basis of compound annual growth rate (CAGR) of triennium averages in area, production and yield per hectare of principal crops at the state as well as regional level.[1] The period of assessment is restricted to post green revolution period from 1970-71 to 1999-2000. Its main focus is on the comparison among three sub periods, viz., the early phase of green revolution period covering from 1970-71 to 1979-80, i.e., period I. The latter phase of green revolution (middle phase) is from 1980-81 to 1990-91, i.e., period II and the last phase is known as liberalization period covering from 1991-92 to 1999-2000, i.e., period III (post liberalization phase).

For the purpose regional analysis, all the 23 districts of Andhra Pradesh are clubbed into three distinct agricultural regions. These districts are classified into major regional groups in order to organize and facilitate the discussion on regional basis if any emerging trend comes during this period under study. The organization of the study of the three regions is as follows.

Coastal Region (CR): Srikakulam, Vijayanagaram, Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam, and Nellore.

Rayalseema Region (RR): Kurnool, Cuddapah, Ananthpur and Chittor.

Telengana Region (TR): Mahabubnagar, Hyderabad, Rangareddy, Medak, Nizamabad, Adilabad, Karimnagar, Warangal, Khammam and Nalgonda.

II Agricultural Performance in Andhra Pradesh

Changes in Cropping Pattern

The distribution of the total cropped area had marginally declined from 12,660,133 hectares in 1970-71 to 11,469,764 hectares in 1998-99. The low value coarse cereals, viz., *jowar* and *bajra* lost their relative share in terms of area, whereas staple foodgrains, viz., rice and some pulses made an accretion to their share. The most significant change occurred that the area under total foodgrains was reduced from 75.71 per cent of the total cropped area in period I to 59.94 per cent in period III, while non-foodgrains crops gained from 24.29 per cent to 40.06 per cent during the same period (Table 1). Generally, the latter have much higher values of per hectare output than that of the former. In a crop wise breakup analysis, rice emerged as the most important one followed by groundnut, cotton, jowar, maize, sugarcane, tobacco and finally an inferior substitute of potatoes, sunhemp and mesta etc.

The changes in the cropping pattern are due to the increase in irrigation and changes in price of crop output (Narain, 1988). Firstly, the net irrigated area has increased from 2,997,568 hectares in 1970-71 to 4,384,126 hectares in 1998-99 in Andhra Pradesh. Moreover, there has been a clear-cut improvement of irrigated area of rice, groundnut and sugarcane, whereas there has been a sharp decline of *jowar*, *bajra*, tobacco and *mesta* during this period.[2] Secondly, the CAGR of price of

important nine crops shows that of *jowar* and *bajra* is almost same with CAGR of rice, maize, groundnut, sugarcane, tobacco and chillies in the nineties. Cotton is only crop, which showed sharp increase of price in different sub periods.[3] Hence, price factor does not show any dominant role for changing the cropping pattern. It is the expansion of irrigation, along with high fertilizer consumption, HYV seeds and increase in per hectare net value of different crops caused for the increase of area under rice, sugarcane, cotton, groundnut and made to decline of relative share of low value crops, viz., *jowar* and *bajra*, tobacco in the total cropped area rather than price.

Table 1: Changes of Cropping Pattern during 1970-2000 in Andhra Pradesh
(Area in per cent)

Crops	Period I	Period II	Period III	Status
Rice	29.00	31.00	32.00	Increasing
Wheat	0.18	0.12	0.009	Decreasing
Cereals	28.82	31.30	32.44	Increasing
Jowar	20.22	15.31	7.7	Decreasing
Bajra	4.52	3.41	1.18	Decreasing
Maize	2.38	2.63	3.05	Increasing
Coarse cereals	27.13	21.35	11.94	Decreasing
Cereals and Millets	64.16	57.97	46.21	Decreasing
Total Pulses	11.30	12.31	13.73	Increasing
Total Foodgrains	75.71	70.29	59.94	Decreasing
Groundnut	10.65	14.30	18.38	Increasing
Total Oilseeds	13.38	19.58	24.81	Increasing
Cotton	2.96	4.20	7.99	Increasing
Sugarcane	1.44	1.52	2.24	Increasing
Tobacco	1.64	1.50	1.45	Decreasing
Onions	0.11	0.14	0.20	Increasing
Metsa	0.86	0.73	0.67	Decreasing
Non-Foodgrains	24.29	29.71	40.06	Increasing
All crops to total geographical areas	43.41	43.85	43.35	Marginally declined

Source: Various Volumes of Statistical Abstract of Andhra Pradesh.

Growth of Agriculture in Andhra Pradesh

The growth performance of foodgrains was much higher than that of non-foodgrains during period I of the study. The growth pattern between foodgrains and non-foodgrains got reversed during eighties. Moreover, the CAGR of foodgrains came down drastically from 3.71 per cent during period I to 1.52 per cent during period II (Table 2). In contrast, the output growth rate of non-foodgrains moved up significantly from 0.39 per cent during seventies to 4.39 per cent during eighties. The growth rate of non-foodgrains production is higher than foodgrains production throughout the green revolution period except the beginning of the green revolution. The major forces behind this widening disparity in growth between two groups of crop during the post green revolution period had been an emergence of acceleration in growth of both area and per hectare yield of non-foodgrains after the eighties, whereas there had been deceleration in the growth of area of foodgrains, though per hectare yield had shown a significant positive growth during the same period. More specifically, the yield effect is stronger than area effect for increasing foodgrains productions, whereas it is the combination of both area and yield effect determined the non-foodgrains production. Moreover, the CAGR of foodgrains production in nineties is quite less than that of seventies; whereas the CAGR of non-foodgrains in nineties is lower than that of eighties. The performance of both foodgrains and non-foodgrains in nineties has declined compared to earlier periods.

Crop wise Analysis of both Foodgrains and Non-Foodgrains Production in Andhra Pradesh

Rice is only crop, which performed positive growth in terms of area, production and yield in all sub periods. Most remarkable, the CAGR of rice production has declined from 4.67 per cent in period I to 2.93 per cent in period II and again declined to 1.21 per cent in period III. The declining in the growth rate of rice is mainly dependent on the declining growth rate of both area and yield in all the sub-periods (Table 2). The growth rate of wheat decelerated from -0.69 per cent in period I to −4.26 per cent during period II along with high deceleration of area than low acceleration of yield rate. Performance of two inferior cereals, viz., *jowar* and *bajra* was significant, i.e., 2.21per cent and 4.41 per cent respectively during period I as the growth rate of yield was high though the area growth rate was negative. The CAGR of production of output of these two coarse cereals declined at a higher rate during period II and III as the area declined at a higher rate (Table 2). The CAGR of maize production was 3.83 per cent with 1.51 per cent of area and 2.21 per cent yield growth rate respectively during period I. The CAGR of output of production of maize declined to -1.87 per cent as the area declined to 0.87 per cent with stagnant growth of yield during period II. During period III, there was an impressive CAGR of production of maize, i.e., 9.07 per cent supplemented by higher growth rate area and yield, i.e., 3.63 per cent and 5.23 per cent respectively. The growth rate of cereals has been mostly at par with foodgrains throughout the green revolution period, as it was declined from 4.13 per cent in period I to 0.99 per cent in period II and again it increased to 1.14 per cent in period III. This is mostly because of significant contribution in yield growth during the three periods, which helped in sustaining output growth despite decline of area under cereals.

Table 2: Crop wise CAGR of Area, Production and Yield in Andhra Pradesh during 1970-2000

Crops	Period I			Period II			Period III		
	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield
Rice	2.37*	4.67*	2.22**	0.74	2.93**	2.12*	0.11	1.21**	1.33*
Wheat	0.67*	-0.69	-1.52	-6.46*	-4.26**	2.25	3.25*	-0.70	-4.07
Jowar	-2.61**	2.21**	4.83*	-6.03*	-6.39*	-0.39	-5.58*	-6.18*	-0.58
Bajra	-0.33	4.41**	4.68*	-8.31*	-9.09*	-0.68	-8.53*	-5.78*	2.52
Maize	1.51*	3.83**	2.21	-0.92*	-1.87**	0.09	3.63*	9.07*	5.23*
Coarse Cereals	-1.87*	2.83**	4.75*	-5.73*	-5.33*	0.41	-3.67*	1.86*	5.65*
Total Cereals and Millets	0.23	4.13*	3.89*	-2.40*	0.99	3.44*	-1.42**	1.14**	2.50*
Total Pulses	-0.07	-0.17	-0.09	0.87*	5.66*	4.77*	0.09	0.13	0.06
Total Foodgrains	0.12	3.71**	3.59*	-1.73*	1.52**	3.31*	-0.29	2.13	2.43**
Groundnut	-1.65***	-3.44**	-1.80**	6.03*	8.56*	2.37*	-3.02*	-3.88	-1.06
Sesamum	-3.65***	-5.96**	-2.29**	-0.77**	-3.49**	-2.79**	-0.29	-0.80	-0.78
Coconut	0.23***	0.04	-0.19**	3.13*	16.18*	12.52*	6.22*	3.69**	-2.44
Sunflower	-5.97	-7.37	-1.77	-6.55*	-4.48**	2.39**	0.83	0.63	-0.12
Total Oilseeds	-2.73**	-3.56**	-0.80	5.43*	8.36*	2.75	-3.70*	-1.34	2.35*
Cotton	1.12	-0.59	-1.54	4.35*	3.18**	-0.94	6.41*	4.46*	-1.83**
Sugarcane	-1.50**	-1.85**	-0.345	-1.59***	-1.99**	1.26	-0.22	2.23**	2.32*
Tobacco	0.46	0.27	1.67	-2.19**	-2.29	0.22	0.23	-1.71	-1.86**
Onion	-0.39	8.42**	8.77*	3.42*	4.10*	0.64	4.89*	12.63*	7.50
Chilies	-1.99***	2.95	4.95*	3.09*	9.49*	6.16*	0.43	5.26*	5.64*
Turmeric	3.52***	5.76**	2.09*	6.78*	6.40*	-0.19	2.02**	8.45**	6.52**
Banana	4.38*	10.36*	5.58**	0.92***	3.70**	2.93	7.19**	7.79*	0.53
Mesta	2.52*	7.82*	5.06**	-3.56*	-5.09**	-1.63**	-0.81	-3.58**	-2.38
Total Non-foodgrains	-1.61	0.39	2.02*	4.47*	4.39*	2.08*	0.18	2.35	3.19**
All Crops	-0.21	2.36**	2.87*	0.12	2.48**	2.34**	-0.89**	1.81	1.51**

Source: Various Volumes of Statistical Abstract of Andhra Pradesh.

Note: The CAGR of Foodgrains, Non-Foodgrains and Al Crops are estimated with the help of taking the index number of area, output and yield with the base year 1970-71= 100 respectively. * indicates 1 per cent , ** indicates 5 per cent , *** indicates 10 per cent level of significance. However, triennium averages are used for estimation of growth rates for various crops.

The performance of groundnut was highly uneven compared to total cereals during different sub periods of the study. It was certainly an improvement of area, production and yield during period II over the declining state of area, output and yield in period I. All the edible oilseeds started a high growth in production, i.e., 8.36 per cent along with high growth rate of area and yield during period II from negative growth of production along with negative growth rate of area and yield during period I of the study. This transition from a negative growth in the oilseeds sector demonstrates the technological improvement and provision of assured and higher market support the oilseeds in the eighties to a positive significant growth of output.

The production of cotton registered relatively high growth, i.e., 3.18 per cent during period II from a negative growth of production during period I. The same trend was continued with a higher CAGR of 4.46 in the nineties. The major driving force for the high growth of production of cotton in eighties and nineties is the area rather than yield. The widespread cultivation of cotton in some pockets of the state is due to its per hectare higher value. It has substituted other crops mainly because of sharp increase of price compared to other crops.

Sugarcane is yet another major commercial crop like cotton, which showed declining CAGR of −1.85 per cent in period I to −1.99 per cent in period II and ultimately increased to 2.23 per cent in period III. The acceleration in production is supplemented by high growth of yield though the growth rate of area continued decelerating throughout the study period. The growth performance of tobacco was worst with the absence of any positive growth of output except period I of the green revolution period. The higher performance of onion production after eighties was supported by both increase in area and yield in the state. The higher growth rate was observed in case of chillies, turmeric, banana, onion throughout the green revolution period and it was mainly supported by higher yield growth rate along with a moderate performance of area growth rate. The performance of *mesta* was declined to negative after eighties both in terms of area and yield despite remarkable performance, i.e., 7.82 per cent in the beginning of the green revolution period.

Given these information, the important findings were emerged during the green revolution period in Andhra Pradesh. Firstly, rice is the only crop under cereal and coconut, onion, chillies, turmeric, banana under non-foodgrains showed continuous positive growth in output, whereas wheat, sesamum, revealed continuous negative growth throughout the green revolution period. Moreover, CAGR of rice has been declining in different sub-periods of the green revolution period, which happened due to declining of both area and yield growth rate. Secondly, *jowar* and *bajra* under coarse cereals, *mesta* under non-foodgrains started declining after the eighties with a remarkable performance at the beginning of the green revolution period, whereas coconut, cotton and sugarcane started performing remarkable positive growth after eighties with a dismal performance in the seventies. Thirdly, maize is the major crops showed negative growth rate at the eighties with a positive growth at the beginning as well as liberalization period of the study. Fourthly, there was dramatic transition from negative to high growth of production in the oilseeds and total pulses from period I to II and again declined in the nineties.

Regional Differences in the Performance of Foodgrains Production

In order to understand the potentiality of regional difference of output performance, it is important to undergo an analysis of per hectare yield (kgs/hectare) in different regions in different sub-periods. The yield per hectare has increased by 2.29 times from 7.30 quintals in 1970-71 to 16.63 quintals in 1998-99 in Andhra Pradesh. The per hectare yield has increased by 1.80 times from 10.04 quintals in 1970-71 to 18.04 quintals in 1998-99 in Coastal region. The per hectare yield of foodgrains is highest, i.e., 13.99 quintals in Coastal region and it is lowest, i.e., 8.76 quintals in Rayalseema region during the study period (Table 3). The special programmes for rice and oilseeds, increasing attention for dry farming made regions to get high yields. This is corroborated by the increase in the consumption of fertilizer and growth of irrigation across regions in the state. In other

words, the region covered by widespread irrigation facility have better yield rate than those of less irrigated area. The important achievement is that the foodgrains production has increased in all regions throughout the study period but in different proportion depending upon the application of technology.

Table 3: Yield of Foodgrains in Different Regions Andhra Pradesh during 1970-2000 (Kgs/hectare)

Regions	Period I	Period II	Period III	1970-2000
Coastal Region	1064	1494	1685	1399
Rayalseema Region	712	827	1121	876
Telengana Region	692	984	1330	979
Andhra Pradesh	846	1215	1463	1156

Source: Various Volumes of Statistical Abstract of Andhra Pradesh.

Coastal Region: The CAGR of foodgrains output in Coastal region was 3.66 per cent in period I with a moderate contribution of yield, i.e., 2.65 per cent and lower rate of area, i.e., 0.97 per cent. The CAGR has declined to 1.22 per cent in period II due to sudden decline of both area and yield compared to period I. The slight improvement of CAGR of foodgrains output, i.e., 1.32 per cent in period III over period II is mainly due to the increase in area (Table 4). It is remarkably observed that output growth is substantially supported at a higher rate of yield than the rate of area throughout the green revolution period. Moreover, though there has been development of technological improvement in the last phase of green revolution period, the CAGR of output was substantially lower compared to period I. In other words, though the per hectare consumption of fertilizer has increased and 55 per cent of net sown area is irrigated in Coastal region, the declining of yield as well as output growth rates of foodgrains production during nineties pose a matter of serious concern.

Table 4: CAGR of Area, Production, Yield of Foodgrains at Different Regions in Andhra Pradesh during 1970-2000

Regions	Period I			Period II			Period III		
	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield
Coastal Region	0.97* (4.63)	3.66* (6.11)	2.65* (4.10)	0.09 (0.24)	1.22** (2.52)	1.12** (3.09)	0.41** (3.52)	1.32 (3.24)	0.91*** (2.07)
Rayalseema Region	-1.25* (_6.43)	1.79** (2.95)	2.99* (6.61)	-4.89* (17.24)	-1.34 (-1.27)	3.66* (3.66)	0.48 (0.86)	0.16 (0.28)	-0.34 (0.58)
Telengana Region	0.63*** (2.32)	8.06* (8.61)	7.41* (11.09)	-1.71 (-4.57)	4.49 (0.36)	5.23** (2.06)	-1.46 (-1.92)	2.77 (0.60)	3.34 (0.58)

Source: Various Volumes of Statistical Abstract of Andhra Pradesh.

Note: The values in the parenthesis are t-values, * indicates 1 per cent, ** indicates 5 per cent, and *** indicates 10 per cent level of significance. However, triennial averages are used for the estimation of growth rates.

Rayalseema Region: The growth pattern of output in Rayalseema region is quite different from that of Coastal region. Starting from a moderate growth of output, i.e., 1.79 per cent in period I, it declined to a negative growth of 1.34 per cent in period II and revived slowly with a growth rate of 0.16 per cent in period III (Table 4). The uneven and insignificant performance of output in different sub periods is significantly determined by the changes of area growth rate rather than yield rate in this region. The growth rates of yield is insignificant because lack of irrigation and high fluctuation of rainfall.

Telengana Region: The CAGR of output started at a higher rate, i.e., 8.06 per cent in period I, suddenly declined to 4.49 per cent in period II and again declined to 2.77 per cent in period III. The CAGR of output is mainly contributed by yield growth rate supplemented by stagnant (sometimes

negative) growth rate of area. The CAGR of output in period III is also less compared to period I & II, which is no way exception to the earlier two regions. The higher CAGR of foodgrains output occurred in this region in period I because of introduction of canal irrigation along with HYVs seeds and fertilizer in the districts of Nizamabad, Adilabad, Karimnagar and Warngal by the Sriramsagar project on the river Godavari. Total canal irrigated area was 85,423 hectares of land in 1973-74 and it has increased to 155,806 hectares in 1998-99 (Nayak, 2002). Most importantly, rice is the only crop which covers 85 per cent of the total irrigated area in this region. The CAGR of foodgrains has declined in the subsequent periods because of dramatic increase of salinity and waterlogging areas in the canal command areas (the details are being analyzed in part IV of this study).

In an inter-regional comparison, the CAGR of output in Telengana region is always highest keeping Coastal region at the middle and Rayalseema region at the bottom during the sub-periods of the analysis. The changes in the growth pattern of foodgrains output is mainly determined by the changes in yield rate in Telengana and Coastal region, whereas the change of area played a significant role for change in output growth in Rayalseema during the sub-periods. In other words, the technological changes played significant role both in Coastal and Telengana region, whereas technological change yet to be reached significantly in the Rayalseema region.

In view of the above analysis, it is revealed that persistence declining state of area along with moderate to low yield growth under foodgrains in all the regions caused declining of CAGR of foodgrains output after seventies. This trend has to be noted as a matter of serious concern with an increasing state of demand for foodgrains in the years to come. Though there has been tremendous technological development in terms of growth of fertilizer and irrigated area and area under HYV seeds, still the output growth rate along with yield growth rate declined. The important reasons are to be investigated further and implementation of the necessary steps is to be strengthened in order to achieve efficiency and sustainability in the agricultural performance of the state.

III Instability in Production of Foodgrains and Non-foodgrains in Andhra Pradesh

Various studies have attempted to estimate the instability of crop output at different regional as well as national level (Mukherjee and Vaidyanathan, 1980; Parthasarathi, 1984; Dev, 1987; Despande, 1988; Rao, Ray and Subbarao, 1988; Rao, 1994; Sharma, 1999). All these studies estimated the instability at different regions for foodgrains by taking the standard deviation of year-to-year growth rates. Here, we have estimated the instability in Andhra Pradesh by adopting the standard deviation of year-to-year growth rate of various crops. This study carried out two exercises, viz., measurement of instability of foodgrains production at regional level in all sub-periods. Secondly, instability of some important individual crop in different sub-periods at the state level.

Instability at Regional Level

The growth rate of foodgrains and non-foodgrians production in Andhra Pradesh during the green revolution period is not only deteriorating after seventies but also unstable. This instability or year-to-year variation of foodgrains production during the sub-periods is quite higher at regional level as well as among some of the crops. The temporal character of variability during the three sub-periods in all the regions of Andhra Pradesh shows that the variation in production is caused by both area and yield, where yield is the prominent factor over area for instability in foodgrains production. The range of instability varied from 10.98 per cent in Rayalseema region to as high as 25.08 per cent in Telengana Region during period I (Table 5). The level of instability declined progressively in Coastal region in subsequent periods, whereas both Rayalseema and Telengana Region did not show any upward or downward movements. However, it is worth mentioning here that foodgrains production in low rainfall and low irrigated Rayalseema and Telengana regions became more unstable throughout the green revolution period compared to Coastal region.

Table 5: Standard Deviation in the Growth Rate of Area, Production, and Yield of Foodgrains

	Year	Coastal Region	Rayalseema Region	Telengana Region	Andhra Pradesh
Area	1970-2000	5.67	26.85	11.63	8.72
	Period I	4.35	4.91	4.95	5.41
	Period II	5.34	15.33	7.13	7.58
	Period III	2.47	5.53	7.66	4.00
Production	1970-2000	23.45	15.17	25.08	19.64
	Period I	13.82	10.98	25.04	15.59
	Period II	9.00	16.02	15.34	12.04
	Period III	6.31	11.66	19.56	10.77
Yield	1970-2000	19.67	24.04	30.41	24.56
	Period I	10.67	11.55	21.72	13.54
	Period II	5.85	19.63	14.26	14.69
	Period III	5.11	10.43	12.74	7.15

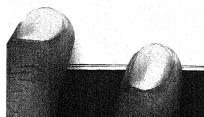Source: Various Volumes of Statistical Abstract of Andhra Pradesh

The instability of various crops varies under rainfed and irrigated condition, again depends upon the durability of crops, level of water consumption and nature of the seasonal production (khariff or rabi season) (Rao, Ray and Subbarao, 1988; Rao, 1994). The variation of rice production is not much lower than other foodgrains production, though most of the rice-cultivated areas are under irrigation (Table 6). Because, the amount of water consumption of rice are higher compared to other crops. The variability of wheat under cereals, jowar, bajra under coarse cereals are higher because these crops are grown up in mostly rainfed condition. The instability of cotton has declined because it consumes less water and grown up in irrigated condition. Though the durability of sugarcane production is higher compared to other crops, yet its variability has been moderate to high because irrigation has not become substantially able to control the instability. The instability of tobacco, onion, mesta etc is higher because these are grown up in rainfed condition. Hence, with the existence of all situations, the instability of individual crops prevailed significantly during different sub period in Andhra Pradesh. Hence, the combined impact of all factors, viz., increase in complementarity between new technology and water on the one hand, rising sensitivity of irrigation due to rainfall variation on the other hand is the cause of continuation of instability in the crop output.

Table 6: Instability in Crops Production during 1970-2000

Crops	Period I	Period II	Period III	1970-2000
Rice	19.62	16.60	17.79	17.31
Wheat	25.32	47.16	27.35	34.58
Total cereals	19.61	16.61	17.73	17.31
Jowar	19.45	27.01	18.53	22.21
Bajra	44.62	26.24	34.52	34.19
Coarse Cereals	18.53	18.72	16.24	17.71
Total Cereals and Millets	15.10	1.75	17.33	14.41
Total Pulses	19.93	14.40	28.00	20.12
Groundnut	32.97	26.55	50.24	35.46
Total Oilseeds	26.00	31.29	49.96	35.00
Cotton	31.00	23.07	16.74	24.00
Sugarcane	12.73	23.88	16.84	18.32
Tobacco	39.00	33.09	17.16	31.00
Onion	33.00	15.96	63.68	39.00
Chillies	45.00	24.77	34.67	34.00
Mesta	24.00	34.19	16.07	32.00

Source: Various Volumes of Statistical Abstract of Andhra Pradesh.
Note: Variation in output production is measured by calculating Standard Deviation in annual growth rates of all crops.

Relationship between Growth and Instability

The relationship between instability and growth can be visualized under two situations. Firstly, a direct or positive relationship where instability become the outcome of growth. Secondly, an inverse or negative association, where higher instability co-exists with low growth and vice-versa (Despande, 1988). In this connection the agricultural sector of an economy may passes through four different phases. Firstly, low growth with low instability. It is a typical stagnant phase, where the agriculture sector or crop cannot derive benefit of the lower instability situation in order to attain higher rates of growth. Secondly, low growth with high instability. This is the most non-preferred stage of an agricultural state, where high instability retards the growth performance by either affecting the input intensity or technology. Thirdly, high growth with high instability. This is the outcome of the application of green revolution technology, viz., irrigation, fertilizer and HYV seeds pushed the economy into a higher growth performance with higher instability. Fourthly, the most preferred phase is high growth coupled with low instability. Here, the application of technology, viz., reliable and widespread source of irrigation with other high yielding technology and its appropriate proportional usage helps to drop down the fluctuations of crop output drastically. In this connection, the relationship between growth and instability can be assessed by taking into regional, crop wise and periodical analysis in Andhra Pradesh during the post green revolution period.

We briefly examine the relationship between growth and instability in Andhra Pradesh by taking into account (a) various regions in different period, (b) various individual crop in different periods, (c) for foodgrains and non-foodgrains and all crops. In order to assess the performance in terms of growth and instability in foodgrains production, we classify the regions and the state as a whole into different groups.

The Coastal and Telengana regions are successful in some extent in terms of performance of foodgrains growth and its instability, i.e., medium growth with high instability during this period.[4] On the other hand, Rayalseema region shows low growth with medium instability. On the whole, there has been low growth with medium instability for foodgrains production during 1970-2000 in the state (Table 7). The analysis of the results shows that there is no basis to believe the hypothesis of high growth causing high instability. Because high instability can also occur without high growth in an agriculturally developed region like Coastal region.

Table 7: Cross Analysis of Regions during 1970-2000

Standard Deviation Of Instability	Growth Rates		
	High CAGR (above 3 per cent)	Medium CAGR (2-3 per cent)	Low CAGR (0-2 per cent)
Low (0-15 per cent)			
Medium (15-20 per cent)			Rayalseema and Andhra Pradesh
High (above 20 per cent)		Coastal and Telengana Region	

Source: Column 1, from Table 5 for instability
Column 2, from Table 4 for growth rates

The relationship between growth with instability of various individual crops shows the established hypothesis of high growth with high instability and low growth with high instability are clearly visible due to the application of green revolution technology. Various high valued crops, viz., cotton, chillies, turmeric, banana, groundnut have achieved high growth with high instability, whereas low valued crops, viz., *jowar bajra, mesta* etc., are coming under the latter one. Most

importantly, rice and sugarcane could not achieve high growth with the application of green revolution technology during the study period in Andhra Pradesh (Table 8).

Table 8: Cross Analysis of Crops in Andhra Pradesh during 1970-2000

Standard Deviation of Instability	Growth Rates		
	High CAGR (above 3 per cent)	Medium CAGR (2-3 per cent)	Low CAGR (0-2 per cent)
Low (0-15 per cent)			
Medium (15-20 per cent)		Rice	Sugarcane
High (above 20 per cent)	Cotton, onion, chillies, turmeric, banana, coconut, maize	Groundnut	Jowar, bajra, wheat, sesamum, sunflower, tobacco, mesta

Source: Column 1, from Table 6 for instability
Column 2, from Table 2 for growth rates

The performance of foodgrains, non-foodgrains and all crops during different sub-periods in the state shows some of the interesting pictures. With the application of green revolution technology, the foodgrains production achieved high growth with a medium instability in period I (Table 9). This achievement justifies substantially our established hypothesis of high growth with high / low instability. The distressing picture of low growth with low instability occurred in eighties for foodgrains. Again, some improvement taken place for movement of medium growth with medium instability in nineties. Similarly, the production of non-foodgrains during seventies was in the beginning stage (Table 9). The most successful stage for non-foodgrains is during eighties to achieve high growth with low instability. But, the achievement of non-foodgrains was deteriorated to medium growth with high instability in nineties. In this regard, the pertinent question arises after achieving a high growth with low instability for non-foodgrains in eighties and high growth with low instability in seventies for foodgrains. What made the agricultural sector of Andhra Pradesh to come down from a high to low growth with low to medium/high instability in the nineties? This deteriorating situation can be assessed by analyzing some of the environmental factor in connection with the application of irrigation and fertilizer consumption during the post green revolution period in Andhra Pradesh.

Table 9: Period wise Classification of Foodgrains, Non-foodgrains and All Crops in Andhra Pradesh during 1970-2000

Standard Deviation	Growth Rates		
	High CAGR (above 3 per cent)	Medium CAGR (2-3 per cent)	Low CAGR (0-2 per cent)
Low (0-15 per cent)	(NFC, II)	(AC, I) (AC, II)	(FC, II) (NFC, I)
Medium (15-20 per cent)	(FC, I)	(FC, III)	(AC, III)
High (above 20 per cent)		(NFC, III)	

Source: Column 1, from Table 6 for instability
Column 2, from Table 2 for growth rates
Notes: FC means Foodgrains, NFC means Non-Foodgrains, AC means all crops.

The above analysis suggests that the first and foremost step is to maintain a balanced growth of agriculture among different regions in the state in order to reduce the instability of the crop output. For this, the development of irrigation from assured sources and its exploration to new areas is highly required. Secondly, exploitation of groundwater in unexplored area is likely to establish stability both by reducing the variability in the khariff output and by expanding the area under the rabi crops through multiple cropping. This could contribute stability in the performance of agricultural sector.

Divergent views were expressed for the reasons of instability of crop output during the post green revolution period in different parts of the country. The variation of rainfall, fertiliser consumption, price of different inputs and other institutional factors causes the instability of the crop output. Among them, the continuation of instability in the crop output is mainly due to the variations of rainfall. The availability of moisture is the important factor for crop growth. Moisture can be obtained either from rainfall or irrigation. Here, irrigation acts as a neutralizing factor for controlling the variation of crop output. In other words, the variation of crop output is less in an irrigated area than the rainfed area. But, the modern inputs, viz., fertilizers, HYV seeds are being complimented to water. As irrigation substantially depends on the availability of rainfall, the demand for these inputs changes with the variation of rainfall, which ultimately affect production (Rao, Ray and Subbarao, 1988; Roa, 1994; Nadakarni, 1994). Secondly, changes in the price of inputs like fertilizer with respect to the output (Ray, 1983; Dev, 1987; Rao, Ray and Subbarao, 1988; Rao, 1994). In view of the above-cited reasons, we have analyzed these factors contributed for the existence of instability of crop output in Andhra Pradesh agriculture.

The instability of most of the crops increased from a low to moderate (some cases high) in nineties in Andhra Pradesh. This is a clear indication that the instability is mainly determined by the variation of rainfall or agro-climatic condition. Firstly, because, nearly 40 per cent of the net sown area is irrigated and more than 40 per cent of this irrigated area is dependent on tanks and wells by the end of nineties, which ultimately dependent on rainfall to a considerable extent (Fertilizer Association of India, 2000-2001). Secondly, 55 per cent of the net sown area is irrigated in Coastal region, whereas only 22 per cent and 37 per cent of the net sown area is irrigated in Rayalseema and Telengana region respectively by the end of nineties. Though canal irrigation used to have stronger stabilizing factor, but it is covered only 34 per cent of the total irrigation and it failed to cover most part of the rainfed area by the end of nineties in the state. Thirdly, tube well irrigation depends on the ground water level, which ultimately depends upon the level of extensive use and rainfall. Based on the availability of data, 40.16 per cent of total irrigation is covered by tube well and others are wells. Though, the quality of tube well is better compared to surface irrigation, these are mostly used for drinking water purposes. Hence, tube well could not substantially check the instability of output in this region. Moreover, price factor could not substantially help for reduction of instability of crop output.

IV   Land Degradation in Andhra Pradesh: Extent, Causes and Consequences

Sustainability of agriculture is one of the important aspects, which safeguard the quality and quantity on natural resources for protecting the interest of the posterities. Among the natural resources, land is an essential input for agricultural growth. However, if it is improperly harnessed, it can also serve as serious threat to sustainable agriculture. There has been environmental degradation by land degradation, water quality deterioration, soil erosion, and deforestation etc. According to NRSA (1995), there are eight important classifications of land degradation (non-forest). These include, gullied or ravenous land, upland with or without scrub, waterlogged and marshy land, land affected by salinity and alkalinity, shifting cultivation area, degraded pastures and grazing lands, degraded land under plantation crop, mining and industrial wastelands. Andhra Pradesh is one of the states, where the land degradation is widespread and prominent. It is estimated that 5,175,019 hectares, which accounts nearly 19 per cent of the total geographical areas as wasteland during nineties in Andhra Pradesh (NRSA, 2000). It is found that the proportion of wastelands to total geographical areas has increased from 11.80 per cent during eighties to 18.81 per cent during nineties in the state.

In addition, Rayalseema region showed the highest accretion followed by Coastal and Telengana region. Similarly, confined to only waterlogging and salinity, the proportion of

waterlogging and salinity to wastelands has shown an accretion from 4.71 per cent during eighties to 5.87 during nineties in the state (Table 10). In toto, the proportion of wasteland to total geographical area in general and waterlogging and salinity to total wastelands in particular has increased from eighties to nineties in the state. It is estimated that fallow land is 42.87 lakh hectares during the 1998-99 in the state (Subrahmaniyam, et al., 2003). In this connection, the growth potential of agricultural crops can be found out by a proper understanding and investigation of relative problems in different regions of the state. For example, the proportion of wasteland to geographical areas has increased from 17.0 per cent in eighties to 26.89 per cent in nineties in Rayalseema region. In a close observation of district wise data, the area under saline and barren land has increased during eighties to nineties in this region. It is clearly reflected that in a dry region, due to scanty rainfall and lack of enough irrigation facilities, the extent of barren land has increased. Hence, irrigation facility must be extended (wherever possible), keeping necessary lands for grazing purposes. On the other hand, as salinity goes hand-in-hand with irrigation, the spread of salinity must be checked with necessary steps. Similarly, the proportion, of wasteland to geographical area in Coastal region has increased from 11.6 per cent during eighties to 18.86 per cent during nineties. In an irrigated developed region, though the fallow/barren land has declined during eighties to nineties in some extend, on the other hand, the area under waterlogging and salinity, gullied and ravenous land has increased during eighties to nineties. Similarly, though the proportion of wastelands to total geographical areas has not increased substantially during eighties to nineties in the Telengana region, yet waterlogging areas has been observed to some extent in nineties in the command areas of Sriramsagar project in the state. Hence, it is always wise to cultivate the fallow land by extending irrigation but on the other hand the negative externalities due to irrigation such as salinity and waterlogging must be checked. The cropping intensity can be increased by the extension of qualitative irrigation.

Table 11: Region wise Wasteland in Andhra Pradesh

Regions	Wasteland as a proportion to total geographical area in eighties	Wasteland as a proportion to total geographical area in nineties	Waterlogging and salinity as a proportion to total Wasteland in eighties	Waterlogging and salinity as a proportion to total Wasteland in nineties
Coastal Region	11.6	18.88	5.78	7.24
Rayalseema region	17.0	26.89	1.07	1.08
Telengana Region	9.86	12.18	0.00	0.60
Andhra Pradesh	11.8	18.81	4.71	5.87

Source: NRSA, 1995 and 2000.

Factors Contributing to Salinity and Waterlogging

Salts occur naturally in most soils and in all sources of irrigation water. Salty soils show high contents of various kinds of salt and / or a high per cent age of exchangeable sodium. Heavily salinized soils may even show efflorescence or complete salt crusts, formed by such salts as gypsum ($CaSo_4$), common salt ($NaCl$), soda (Na_2Co_3) or more complex salts. Salty soils come into being because either the parent material was salty or by irrigation with salty water or they flooded by sea water. The majority of the salty soils however develop as a result of the upward capillary flow of water exceeding its downward movement (Ahmad & Gary, 1992). However, the factors contributing to the existence of salinity in the irrigated land are a complex web of technical, economic, political and social elements. Salinity occurs when the salt balance in the soil is disturbed. It takes place due to indiscriminate use of canal water for irrigation, deep percolation of water in arid and semi arid areas, excessive and inappropriate use of chemical fertilizers and pesticides on the soils (Umali, 1993). Even if irrigation water is relatively free of salts, repeated irrigation which induces a rise in the water table will dissolve the salts in the soil and bring them towards the surface. Neither evaporation nor transpiration removes salts, so they continue to buildup in regions ever closer to the surface (Ahmad & Gary, 1992). Similarly, waterlogging occurs due to continuous rise in the sub-soil water

table, heavy precipitation and floods resulting in prolonged inundation also cause a rise in the water table, poor maintenance of canals or inadequate lining also lead to waterlogging. Waterlogging also causes salinity and provides a conductive habitat for vector breeding. In India, the typical situation in most irrigated commands is over watering in the head reaches and lack of water at the tail. This contributed significantly to localized waterlogging and salinization in head ends of command areas (World Bank, 1991). The over application by farmers is partly attributable to the lack of awareness about proper water application methods and water management, government policies, particularly water pricing policies play a more significant role in determining the technologies adopted and levels of farmers water use.

Extent of Salinity and Waterlogging

Salinity builds up is a long degenerative process. It may take as long as fifteen or more years to appear after the introduction of irrigation (Umali, 1993). The irrigation induced salinity can arise as a result of the use of any irrigation water, irrigation of saline soils and arising levels of saline ground water. When the surface or ground water containing mineral salts is used for irrigating crops, salts are carried into the root zone. Most of the water returns to the atmosphere through transpiration by plants and through evaporation from the soil surface. In the process, the salts are left behind in the soil, since the amount taken up by plants and removed at harvest is quite negligible. The primary adverse effect of excessive salinity is to raise the concentration of soil solution as a result of which the flow of water into the plant by osmosis is reduced or reversed and the plant is starved of water even though the soil is moist (Garg and Gupta, 1997).

It is a fact that irrigation induced salinity and waterlogging, saline soils in other cultivated land have been spread over years in Andhra Pradesh. However, the area under salinity and alkalinity[5] has gone up in the state. In fact, the total salt affected area is found nearly 20,300,000 hectares covered throughout the state (APPCB, 2000). Moreover, salinity lands are observed in the canal command areas. It is estimated that 111,400 hectares of lands are saline in five major command areas in the state (Table 11). Hence, it is clearly revealed that another 202 lakh hectares of saline lands are widespread in other medium & small command areas as well as non-command areas. In addition, waterlogging is also another dominant form of land degradation in the state. It is found that 739,790 hectares are waterlogging area widespread in five major canal command areas in Andhra Pradesh (Table 11). In other words, there has been 19.41 per cent of the net cropped area affected by salinity and waterlogging in the state. Saline soils occur in large areas covering the Coastal sands in the Coastal districts. Saline-alkali soils occur to a large extent in the Coastal districts, Anantapur and Kurnool districts of Rayalseema and many parts of Telangana districts. In the Telangana region, especially in the district of Nalgonda and Mahaboonagar, alkali soils have become widespread due to irrigation with poor quality water having loaded with residual Sodium Carbonate. Nearly, 1,14, 000 hectares of lands are affected by waterlogging and salinity in Guntur and Prakasam districts under the Nagarjunsagar Right Bank Canal. More than 60,000 hectares are alkaline lands in the districts of Anantapur, Kurnool, Medak, Nalgonda and Mahaboobnagar.

Table 11: Extent of Salinity/ Alkalinity and Waterlogging in selected Canal Command Area in Andhra Pradesh

Name of the command area	Salinity areas (hectares)	Waterlogging areas (hectares)
Sriramsagar Project	1, 000	110, 516
Nagarjunsagar Left Bank Canal	26, 400	239, 400
Nagarjunsagar Right Bank Canal	69, 200	106, 570
Tungabhadra canal	14, 800	171, 000
Srisilam Right Branch Canal	NA	12, 304
Total	111, 400	739, 790

Source: Report of the Andhra Pradesh Pollution Control Board, 2000.

Impacts of Salinity and Waterlogging on Productivity

The expanded dependence on irrigation has not been without cost. Salinity and waterlogging, soil erosion and sedimentation, the spread of disease-carrying organization and water pollution are a few of the serious problems that have gone hand-in-hand with irrigation. The plant growth is retarded both by soil salinity and salinity of irrigation water. Salts affect crops through the increased osmotic pressure of the soil solution, which results in a reduction of a plants capacity to withdraw water from soil. The canal irrigation network in the command areas had generated a chunk on the fertility of the soil and made these areas out of cultivation (Jhosi and Agnihotri, 1984; Chopra, 1989). The problem of waterlogging and salinity reduces intensity and productivity of various crops, viz., rice, wheat, sugarcane etc. in the canal command areas (Abrol, 1984; Yudelman, 1989; Joshi, 1987; Chopra, 1989; Joshi, et al, 1992; Datta, et al, 2000). In Andhra Pradesh, paddy, sugarcane, groundnut is cultivated mostly in the canal-irrigated area and the canal irrigated command areas are suffered from the salinity and waterlogging problems. The decline of crops output in the canal as wall as other command areas is due to saline soils in the nineties. However, it is estimated that the value of paddy cultivation declines annually up to 5 per cent due to saline and waterlogging soils in the Sriramsagar command area in the state (Nayak, 2003).

Therefore, the important strategy has to be implemented to achieve sustained growth of agricultural production to control salinity and waterlogging in the cultivated land. Salinity can be controlled by promoting the water use efficiency at both on farm and off-farm level. More water use efficient technologies such as pipe, sprinkler and drip system can be promoted wherever it is technologically and economically feasible. Moreover, alternate crop mixes should be introduced to the farmers in the salinity affected areas, where technical measures to correct for it are shown to be economically or technically infeasible. The cultivation of more salt-tolerant crops can alleviate or remedy the decline in farm income resulting from the reduced output of the traditional crops. However, the cultivation of salt tolerant crops should not be undertaken as a substitute for good cultivation practices. The most effective solution for the waterlogging is a properly designed drainage system. Investigations of projects should include topographical, geological and soil surveys. The nature of soils and sub-soils from the point of view of permeability should be studied. However, drains must be deep enough to keep the ground water at a level, which would not be harmful to standing crops. Lining is of great importance in areas, which on the introduction of irrigation are liable to waterlogging and salinity. Crops require more water should be controlled and less water consumption crops are to be encouraged. Land shaping is necessary to prevent the accumulation of water in the fields. The practice of conjunctive use of surface and groundwater should be adopted to have favourable effect in making available irrigation water in desired quantity and time.

Fertilizer and Environment

The crops and plants cannot take all the fertilizers applied and significant portion is lost in the soils. It means, application of more than the required quantity of fertilizers remains in the field, ultimately leads to polluting the soils. The excess or inappropriate consumption of various fertilizers than the recommended quantity or ratio leads to polluting the soil, which ultimately causes for the decline of productivity of various crops. The excess amount of nitrogen applied in the soils automatically converts into nitrate. As nitrate is not observed by most soils, it remains in solution. If it is not taken up by plant roots, it is either washed into the drainage water or biologically reduced to dinitrogen gas. Nitrate that is washed out of the soil represents an economic loss to the farmers and possible health hazard if it reaches drainage water (Wild, 2003). Dev, et al. (1995) found that one of the effects of excessive fertilizer use is the contamination of ground water. Grewal and Rangi (1983) found that at a low level of fertilizer use in the earlier years the response was higher compared to the later period, when the use has increased for wheat in the state of Punjab. Rao (1994) found that the major source of environmental degradation in rural areas is the misapplication of yield increasing

inputs like water, chemical fertilizers, and pesticides causing waterlogging, salinity and pollution of drinking water and loss of fish etc. However, chemicalization of agriculture may pose a greater threat to the rural economy at much higher levels of application of chemical fertilizers and pesticides.

In order to fix the balanced use of nitrogen (N), phosphorous (P) and potassium (K), the standard suitable mix of NPK has been estimated at all India level by keeping the soil, climatic condition, cropping pattern and other variables into consideration. Accordingly, the suitable mix of NPK in the country is 4:2:1 (Government of India, 2000-2001). The use of NPK ratio in different sub-periods at regional as well as aggregate level in Andhra Pradesh shows serious imbalance, viz., 9.20:3.27:1 during the green revolution period (Table 12). Of course, the optimum ratio depends on the soil type and other agro-climatic characteristics. However, it shows the consumption of nitrogenous variety of fertilizer is quite higher than the standard mix. The mix imbalances are more serious in Telengana region than Coastal and Rayalseema region throughout the green revolution period. The mix imbalances are more acute during seventies in Coastal region, whereas it was equally imbalanced throughout the green revolution period in the Telengana region. The consumption of fertilizer for various crops is not only inappropriate but also excess than the recommended quantity/ ratio in the state. Subrahmanyam, et al. (2003) found that the level of application of fertilizer is higher than the recommended level for most of the crops. For instances, the application is higher by 48 per cent for paddy and 17 per cent for groundwater. However, there is a short fall in the fertilizer use for sunflower, jowar and sugarcane. This excessive use of fertilizer could be a damaging factor for the environment and decline of productivity. The study by APPCB (2000, p.17) revealed that "the per hectare yield of paddy, maize & cotton has increased more in between 1972 and 1982 but much less between 1982 and 1992. Similarly, the per hectare yield of groundnut and sugarcane has declined between 1982 and 1992. According to departmental statistics, chemical fertilizers seem to have peaked in productivity per hectare between 1978 and 1986. Thereafter, there has been a steady decline in productivity." Moreover, the same study also found that the constant, unabashed use of chemical fertilizers has left the soils in a totally bad shape. However, there is not much scope for attaining growth through increasing fertilizer use except in selected pockets of the state with the existing technology and irrigation level (Subrahmanyam, et al., 2003).

Table 12: Ratio of Fertilizer Consumption in Andhra Pradesh during 1970-2000

Regions	Periods	NPK ratio
Andhra Pradesh	1970-2000	9.20:3.27:1
	Period I	10.06:3.12:1
	Period II	8.14:3.17:1
	Period III	9.46:3.59:1
Coastal Region	1970-99	9.68:4.45:1
	Period I	12.96:15.20:1
	Period II	7.97:2.80:1
	Period III	8.27:6.95:1
Rayalseema Region	1970-2000	5.86:2.78:1
	Period I	9.42:3.33:1
	Period II	3.18:2.17:1
	Period III	4.17:2.86:1
Telengana Region	1970-2000	11.17:4.19:1
	Period I	10.87:3.12:1
	Period II	11.27:4.45:1
	Period III	13.48:5.05:1

Source: Various Volumes of Fertilizer Statistics, Fertilizer Association of India.

Moreover, the imbalance in standard mix of NPK ratio is also widespread to individual/seasonal crops in Andhra Pradesh. The standard ratio for individual crop is prescribed

based on the climatic, soil condition and availability of water in the state (Fertilizer Association of India, 2000-2001). As there is no availability of crop wise fertilizer consumption data at the state level, the comparison of ratio of the fertilizer consumption with khariff and rabi season crops are estimated (Table 13). Moreover, the estimated figure shows that none of the year or season is closer to the crop wise prescribed ratio. Hence, it is a clear indication that though there have been changes in cropping pattern with the development of green revolution technology yet there have been widespread imbalances in the use of NPK at aggregate level in the state as well as season wise in various crops.

Table 13: NPK Ratio of Khariff and Rabi Crops in Andhra Pradesh

Year	Coastal Region		Rayalseema Region		Telengana Region		Andhra Pradesh	
	Khariff	Rabi	Khariff	Rabi	Khariff	Rabi	Khariff	Rabi
1975-76	14:3:1	15:3:1	9:3:1	10:3:1	13:3:1	26:3:1	13:3:1	15::3:1
1981-82	5:2:1	10:3:1	4:2:1	4:1:1	8:4:1	11:3:1	6:3:1	8:3:1
1993-94	11:5:1	12:3:1	10:5:1	12:3:1	15:6:1	17:5:1	11:5:1	13:3:1
2000-2001	5:3:1	6:3:1	5:4:1	6:3:1	9:4:1	9:4:1	7:4:1	7:3:1

Source: Various Volumes of Fertilizer Statistics of India

The imbalanced ratio in the consumption of fertilizer is mainly due to inappropriate price policy of the government. The price policy is biased towards consumption of nitrogenous fertilizers. To make fertilizers available to farmers at affordable prices, the Central Government continued providing urea at a subsidized rate and decontrolled the phosphatic and potassic fertilizers (Government of India, 2001-02). Consequently, the prices of these fertilizers rose sharply resulting in fall in their consumption due to the decontrol of phosphatic and potassic fertilizers. On the other hand, the consumption of urea increased sharply in the recent years. Sometimes inadequate knowledge of farmers about the mechanism to apply fertilizer (based on what proportion, when and why these inputs have to be used) has led to   progressive deterioration of crop yield. Moreover, inadequate training facility by the agricultural department to disseminate knowledge to the farmers for the application of fertilizer with regards to rainfall, soil condition and other agro-climatic situation.

The consumption of chemical fertilizers can be controlled by using organic fertilizers. Biological control technique for pest and disease control etc. can be made easily available and subsidized. Proper agricultural extension services to advice and educate the farmers on the use of fertilizer and pesticide is highly essential. Moreover, providing subside on fertilizer has increased its consumption rather than judicious and efficient use. This consumption has increased mostly on nitrogenous fertilizer. Hence, reducing subside of nitrogenous fertilizer would decline its consumption and make appropriate mix as well as judicious and efficient use in the irrigated areas. There are certain types of micronutrients can supply nitrogen to crops. For example, blue green algae are found to be a good source of nitrogen. Leguminous plants have bacteria associated with them that fix nitrogen. In order to reduce pollution, it requires that fertilizers of right type be applied in optimum quantity at the right time.

Summary and Conclusion

The following are the broad findings emerged from the above analysis. Firstly, the foodgrains share was declined from seventies to nineties, whereas Non-foodgrains crops had made accretion to the overall increase in the cropping pattern due to technological development in the state. Secondly, the CAGR of foodgrains production in nineties is quite less than that of seventies; whereas the CAGR of non-foodgrains in nineties is lower than that of eighties. The performance of both foodgrains and non-foodgrains has declined compared to the earlier periods. Thirdly, the agricultural performance of the state has moved from high growth with low instability for non-foodgrains in eighties and high

growth with low instability in seventies for foodgrains, to low growth with low to medium/high instability in nineties. Fourthly, the proportion of the wasteland to total geographical areas has increased during eighties to nineties in the state. However, there have been 19.41 per cent of the net cropped areas affected by salinity and waterlogging in major irrigated command areas of the state. Moreover, the use of fertilizers is felt excessive and unbalanced, which caused for polluting the soil in large irrigated as well as unirrigated areas. Hence, the losses of agricultural output would not only continue but also increase in the absence of mitigating methods to check the environmental degradation. Thus, various measures are to be strengthened for further development of agricultural sector in the state.

Notes:

---

1   The CAGR obtained by fitting the standard form Log Y= a + bT to the trend of area, production and yield per hectare by Ordinary Least Square (OLS). Additionally, CAGR is estimated for three sub-periods of Andhra Pradesh as well as regional level for foodgrains. Moreover, the CAGR of all crops are estimated by taking triennium averages. Several studies have attempted for measuring the growth of crop output by fitting linear, log-linear, quadratic, log-quadratic. These studies have pointed out a number of methodological issues in choosing an appropriate form (Vaidyanathan, 1979; Sawant and Achuthan (1995); Mohanam, 2002).

2   Rice, sugarcane and groundnut accounted nearly 84.88 per cent of total irrigated area, whereas other crops only 15.12 per cent during the green revolution period in the state (CMIE, 2001).

3   The CAGR for various crops are estimated based on the availability of price data (GOAP, 2000). The CAGR in nineties are as follows. Rice is 9.65, Bajra is 7.12, jowar is 9.65, Maize is 6.01, groundnut is 5.55, cotton is 8.86, sugarcane is 8.56, tobacco is 8.14 and Chilies is 2.91.

4   The classification of low, medium, high standard deviation and growth rates are based on the classification of Dev (1987); Rao, Ray and Subbarao (1988).

5   Though the salts content differs in the saline and alkali soil, we have considered both category of land into saline land only.

References

Abrol (1984), "Alkali Soils and Their Management: A Case Study From India", *Twelfth International Congress on Irrigation and Drainage,* Vol.1 (B), Fort Collins, USA.

Ahmad & Gary (1992), "Irrigation Planning with Environmental Considerations: A Case Study of Pakistan's Indus Basin", *World Bank Technical Paper,* No. 166, The World Bank, Washington, D.C.

Andhra Pradesh Pollution Control Board (2000*), State of Environment in Andhra Pradesh*, APPCB, Hyderabad.

Chopra (1989), "Dimensions and Causalities", *Indian Journal of Agricultural Economics,* Vol.44, No.1, Jan-March.

CMIE (2001), *Centre for Monitoring Indian Economy*, Economic Intelligence Service, Pvt. Ltd. Company, Agricultural Special, September, Mumbai.

Datta and Dayal (2000), "Irrigation with Poor Quality Water: An Empirical Study of Input Use, Economic Loss and Coping Strategy" *Indian Journal of Agricultural Economics*, Vol.55, No.1, Jan-March.

Despande (1988), Growth and Instability in Maharastra Agriculture", *Artha Vijnana*, Vol.30, No.4.

Dev (1987), Growth and Instability in Foodgrains Production: An Inter-State Analysis", *Economic and Political Weekly*, Vol.22, No.39.

Fertilizer Association of India (2000-2001), *Fertilizer Statistics*, New Delhi

Garg and Gupta (1997), *Saline Wastelands, Environment and Plant Growth*, Scientfic Publishers, Jodhpur.

Grewal and Rangi (1983), "An Analytical Study of Growth of Punjab Agriculture', *Indian Journal of Agricultural Economics"*, Vol.38, No.4.

Government of Andhra Pradesh (2000-2001), *Statistical Abstract of Andhra Pradesh*, Director of Economics and Statistics, Hederabad.

Government of Andhra Pradesh (2000), *Wholesale Price of 30 Agriculture Commodities in Andhra Pradesh,* Director of Economics and Statistics, Hederabad.

Government of India (2001-2002), *Economic Survey 2001-2002*, Ministry of Finance, Economic Division, New Delhi.

Joshi and Agnihotri (1984), "An Assessment of the Adverse Effects of Canal Irrigation in India", *Indian Journal of Agricultural Economics*, Vol. XXXIX, No.3, July- September.

Joshi and Jha (1992), "An Economic Inquiry into the Impact of Soil Alkalinity and Water logging", *Indian Journal of Agricultural Economics*, Vol.47, No.2, April-June.

Joshi (1987), "Effects of Surface Irrigation on Land Degradation: Problems and Strategies", *Indian Journal of Agricultural Economics,* Vol.42, No.3, July-Sept.

Mohanam (2002), *The Determinants of Fertilizer Consumption and its Growth,* Northern Book Centre, New Delhi.

Mukherjee and Vaidyanathan (1980), "Growth and Fluctuations in Foodgrains Yeilds per hectare- A Statewise Analysis', *Indian Journal of Agricultural Economics,* Vol.35, No.2.

Nadkarni (1994), "Agriculture and Environment", *Economic and Political Weekly*, Vol24, No.28, July.

National Remote Sensening Agency (1995), *Report on Area Statistics of Land Use/Land Cover Generated by Using Remote Sensing Techniques*, NRSA, Department of Space, Balanagar, Hyderabad.

National Remote Sensening Agency (2000), *Report on Area Statistics of Land Use/Land Cover Generated by Using Remote Sensing Techniques*, NRSA, Department of Space, Balanagar, Hyderabad.

Narain (1988), "Growth of Productivity in Indian Agriculture", in Raj, K.N.: A.K.Sen; C.H.Hanumantha Rao (eds.), *Studies on Indian Agriculture*, Oxford University Press, Delhi.

Nayak (2002), *"Irrigation and Economic Development: Cost Benefit Analysis of Sriramsagar Project in Andhra Pradesh"*, an unpublished Ph.D thesis awarded by University of Hyderabad, Hyderabad.

Nayak (2003), *"Extent and Costs of Environmental Degradation in Sriramsagar Project Command Area: Integration with Cost Benefit Analysis"*, Artha Vijnana, Forth Coming issue.

Parthasarathi (1984), Growth Rates and Fluctuations of Agricultural Production: A District wise Analysis in Andhra Pradesh, *Economic and Political Weekly*, Vol.22, No.39.

Ray (1983), "An Empirical Investigation of the Nature and Causes for Growth and Instability in Indian Agriculture", *Indian Journal of Agricultural Economics*, Vol.38, No.4.

Rao (1994), *Agricultural Growth, Rural Poverty and Environmental Degradation*, Oxford University Press, New Delhi.

Rao, Ray and Subbarao (1988), *Unstable Agriculture and Drought: Implications for Policy*, Vikas Publishing House, New Delhi.

Reddy (1995), "Environment and Sustainable Agricultural Development: Conflicts and Contradiction", *Economic and Political Review*, March 25.

Sawant and Achuthan (1995), Agricultural Growth across crops and regions: emerging Trends and Patters, *Economic and Political Weekly*, Vol.30, No.12, March, 25.

Sharma (1999), "Performance & Regional Variation in Indian Agriculture", *Productivity*, Vol.39, No.4.

Subrahmanyam, et al. (2003), Agricultural Growth: Pattern and Prospects, *Economic and Political Weekly*, March 22-29.

Umali, (1993), "Irrigation-Induced Salinity: A Growing Problem for Development and the Environment", *World Bank Technical Paper*, No. 215, the World Bank, Washington, D.C.

Wild, Alan (2003), *Soils, Land and Food: Managing the land during the twenty first century*, Cambridge University Press, Cambridge

World Bank (1991), *India, Irrigation Subsector Review, Vol.II, Supplementary Analysis, Report No.9518-IN*, Washington, D.C., The World Bank.

Yudelman (1989), *Sustainable and Equitable Development in Irrigated Environments*, Leonard Publication.